Phosphorus Improves Crop Quality

Higher crop quality from P fertilization is a bonus on top of higher yields. Phosphorus improves crop quality in many ways: less grain drying expense, higher sugar content, less disease loss, improved winter survivability, less dockage, a greater proportion of marketable yield, better feed value, and improved drought resistance.

Improved crop quality is a benefit of phosphorus (P) which may be overlooked. Quality factors include maturity, winterhardiness, sugar content, feed value, or reduced disease loss for various crops.

Lower grain moisture of corn at harvest is an added advantage of P fertilization often overlooked.

It is easy to see corn maturing faster. However, another important benefit of P fertilization is a lower drying expense. An example from Ohio, shown in **Table 1**, demonstrates this well.

Phosphorus increased corn yield by a profitable 34 bu/A, while reducing grain moisture by nearly 3 percent. This translated into a savings of $10/A, assuming a drying charge of 2¢ for each percent of moisture removed per bushel.

Iowa State research has shown that when corn is grown on high P soils, grain produced is significantly higher in P content. Producing high yielding corn on high P soils could help reduce the soil P content while at the same time providing a higher P grain for livestock feed. This also means that uptake and removal estimates used for nutrient management planning should be based on grain analysis rather than standard tables.

A higher sugar content was the result of P fertilization of sugarcane in a Louisiana experiment.

Improved survival of winter barley was a quality benefit of P found by New York researchers. The initial level of soil P played a major role in determining barley yield. Direct applications of fertilizer P could not compensate completely for a low P soil, as shown in **Table 2**.

In Manitoba, P increased winter survival of zero-tilled wheat. Without P, 60 percent of the plants survived compared to 74 percent survival with 45 lb/A of applied P_2O_5. In Alberta, 40 lb/A of P_2O_5 improved the cold hardiness of winter wheat crowns. Temperature causing 50 percent mortality was 11.3 degrees F without P_2O_5, compared to 7.2 degrees F with P_2O_5.

Virginia workers found that in addition to raising soybean yields, germination and the percent of sound seed were improved by 120 lb/A of P_2O_5 (**Table 3**). A 400 lb/A rate in a separate study reduced purple seed stain of soybeans by 6 percent.

Orange quality and total marketable yield were improved by P in Arizona research. Several important characteristics of orange production were affected.

- Percent juice by weight was increased by 7 percent.
- Solid-acid ratio was reduced by 7 percent,

TABLE 1. Phosphorus increases corn yields, reduces grain moisture, and cuts drying costs (Ohio).

P_2O_5 rate, lb/A	Corn yield (15.5% moisture), bu/A	Grain moisture, %	Drying cost saved,[1] $/A
0	145	27.0	—
20	158	26.0	3
40	169	25.5	5
80	174	24.6	8
120	179	24.2	10
Response to P	34	2.8	

[1]Assuming 2¢ for each percent of moisture removed per bushel.

indicating a sweeter fruit.

- Marketable fruit yield was increased by 16 percent.
- Peel thickness was reduced by 8 percent.
- Fruit culled by weight was reduced by 12 percent.

TABLE 2. For best survival of winter barley both a higher soil test P level and applied P are needed (New York).

Applied P_2O_5, lb/A	Initial soil P level: Low	Medium	Medium-high	Response to soil P, %
	% plant survial			
0	17	43	79	62
20	33	59	81	48
40	35	59	84	49
80	45	63	92	47
Response to applied P	28	20	13	

TABLE 3. Phosphorus increases soybean yield and improves seed quality.

	P_2O_5, lb/A: 0	120	Yield/ quality response to P
Soybean yield, bu/A	32	41	9 bu/A
Sound seed, %	70	80	10%
Germination, %	85	95	10%

TABLE 4. Effect of residual P applications and applied P on raising the P content of wheat grain.

P applied with seed, lb/A P_2O_5	Residual P, lb/A P_2O_5: 0	820	Response to residual P
	Percent P in grain		
0	0.31	0.40	0.09
102	0.35	0.41	0.06
Response to applied P, %	0.04	0.01	

The P content of wheat is an important quality factor because it affects the grain's worth as an animal feed. Wheat grown in Saskatchewan, for example, often tests below the minimum P requirement for animal feeding. Researchers looking for ways to elevate wheat grain P content to acceptable levels found that residual soil P was more effective than P applied with the seed at planting (**Table 4**). The benefit from the residual P persisted for eight years.

Improved drought resistance is another quality benefit of P fertilization. In Ohio research, a good year was followed by a year of greater heat and moisture stress. The P in the stress year boosted soybean yields by 6 bu/A, compared to no yield increase in the good year.

Market quality of potatoes is strongly affected by P nutrition. Inadequate P results in small tubers that do not meet size and grade standards. Adequate P produces a large percentage of U.S. No. 1 potatoes.

Apple quality also appears to be linked with P compounds. In fruit with superficial scald, when comparing the scald-affected side to the unaffected side, all P compounds are higher in the good side.

Processor interest in protein and oil components is increasing, and understanding the P nutrition impacts on these components will become more important. Research into the impact of soil nutrient levels on the food and feed quality constituents of soybeans and grains is just beginning. Initial work shows that variability of quality components is controlled up to 60 to 65 percent by environmental conditions, including soil nutrient levels. The other 35 to 40 percent is controlled by genetics.

Genetic engineering is providing a wide range of new crop varieties, some specifically developed to produce pharmaceuticals and special nutrient components for human or animal diets. These "nutraceutical" crops are just beginning to be studied in production systems, but it is anticipated that soil fertility levels, including P, will be important in determining yield and composition of such crops. BC